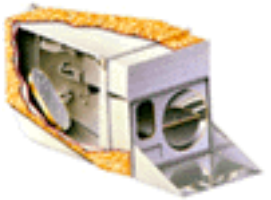


MODIS Instrument Status

Jack Xiong

Biospheric Sciences Branch 614.4, NASA/GSFC

MODIS Science Team Meeting, Washington, DC 20024 (January 26, 2010)

MODIS

- Terra MODIS: over 10 years of successful operation
- Aqua MODIS: over 7.5 years of successful operation
- Important contributions for studies of the Earth's land, oceans, and atmosphere systems and environmental and climate change

Launch: 12/18/99
1st Light: 02/24/00

International Earth Observing Constellations
Complementary Morning and Afternoon Obs.

Launch: 05/04/02
1st Light: 06/24/02

- MODIS Science Team Leader: Michael King
  - Greetings and best wishes from V. Salomonson
- Successful Senior Review for Terra and Aqua Missions
  - Terra effort led by M. Imhoff and Aqua by C. Parkinson
  - MODIS effort led by M. King with input from discipline leads and support teams
- MODIS Calibration Workshop (Jan. 25, 2010)
  - Well attended (over 69 participants)
  - Presentations from MCST and science representatives, covering a broad range of sensor calibration and performance issues.
  - Materials now available at ftp://mtvs1.nascom.nasa.gov/outgoing / mcst-temp/ and later on MODIS website

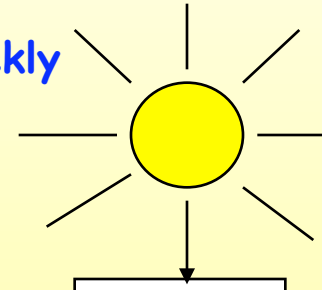
Instrument Operations

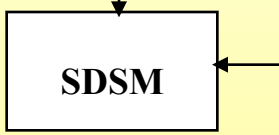
- Terra MODIS
  - A-side: launch to Oct 30, 2000
  - B-side: Oct 30, 2000 to June 15, 2001
  - A-side: July 02, 2001 to Sept 17, 2002
  - A-side electronics and B-side formatter: Sept 17, 2002 to present
  - BB temperatures set at 290K
  - Cold FPA (SMIR and LWIR) controlled at 83K
- Aqua MODIS
  - Same B-side configuration since launch
  - BB temperatures set at 285K
  - Cold FPA (SMIR and LWIR) controlled at 83K

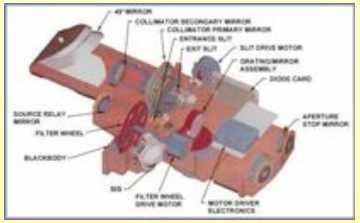
On-orbit Calibration

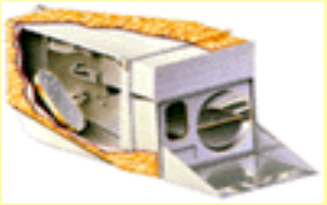
SRCA:
Radiometric: monthly
Spatial: bi-monthly
Spectral: quarterly

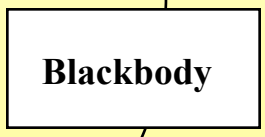
SD/SDSM:
Weekly to tri-weekly





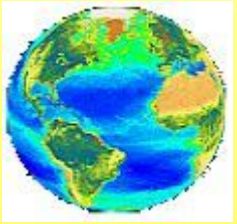






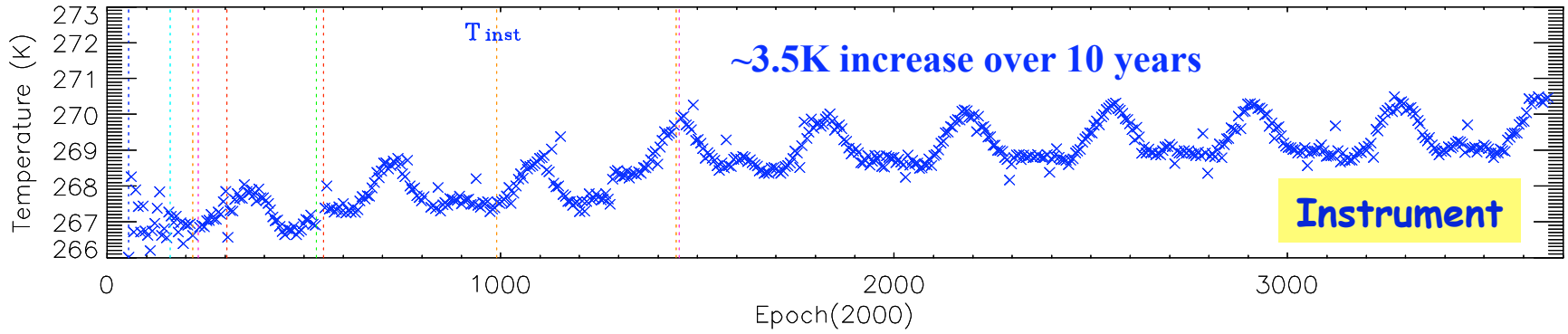
BB: quarterly

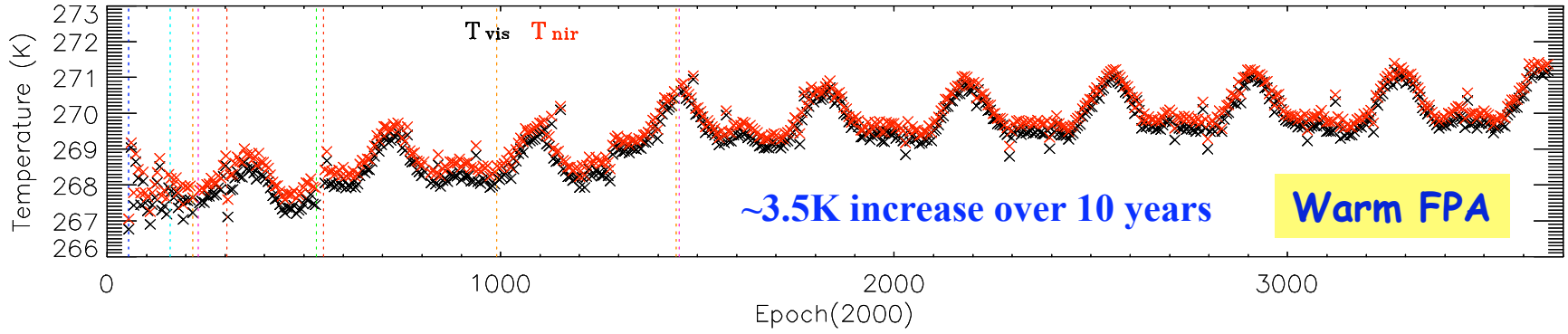
Spacecraft maneuvers:
Yaw (SD BRF, VF)
Roll (Moon)
Pitch (only applied to Terra)

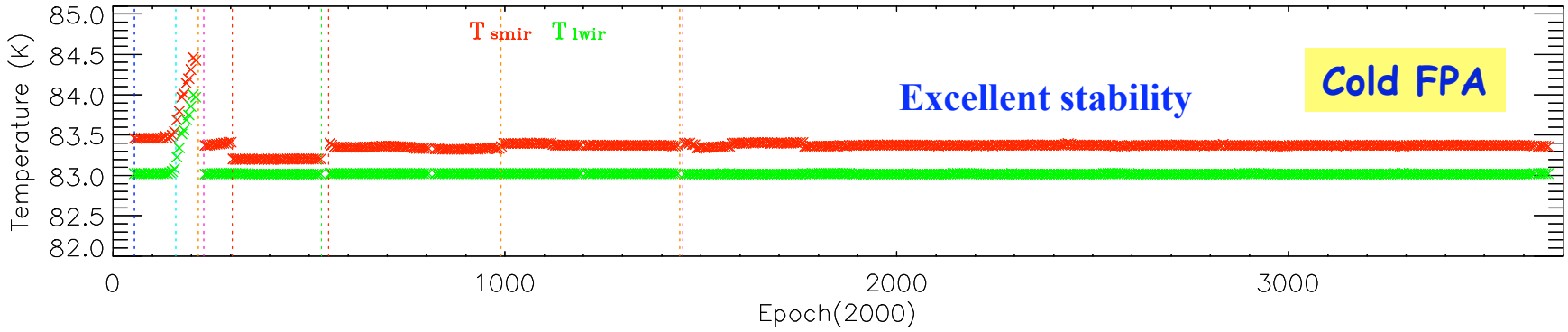


Moon: monthly (nighttime orbits)
0-20° spacecraft roll maneuvers
55° phase angle

Terra MODIS Instrument and FPA Temperatures

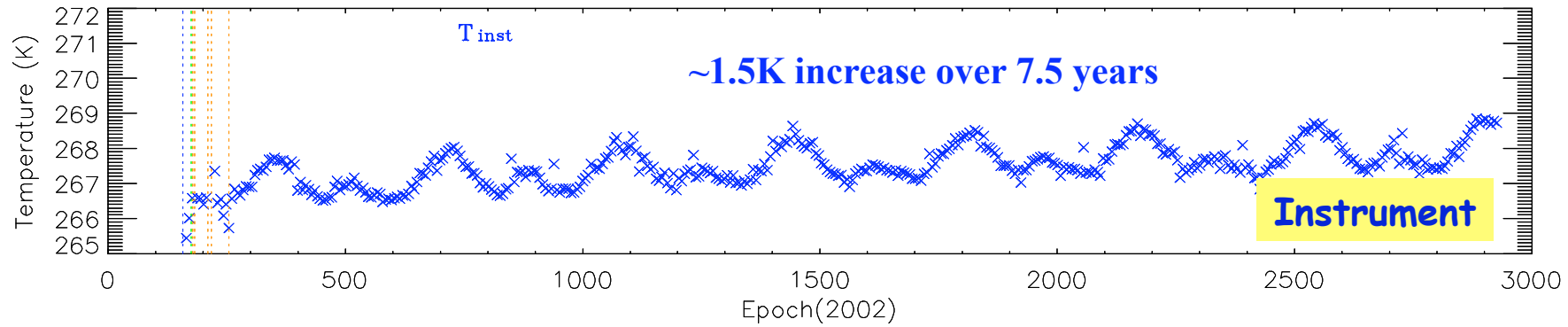


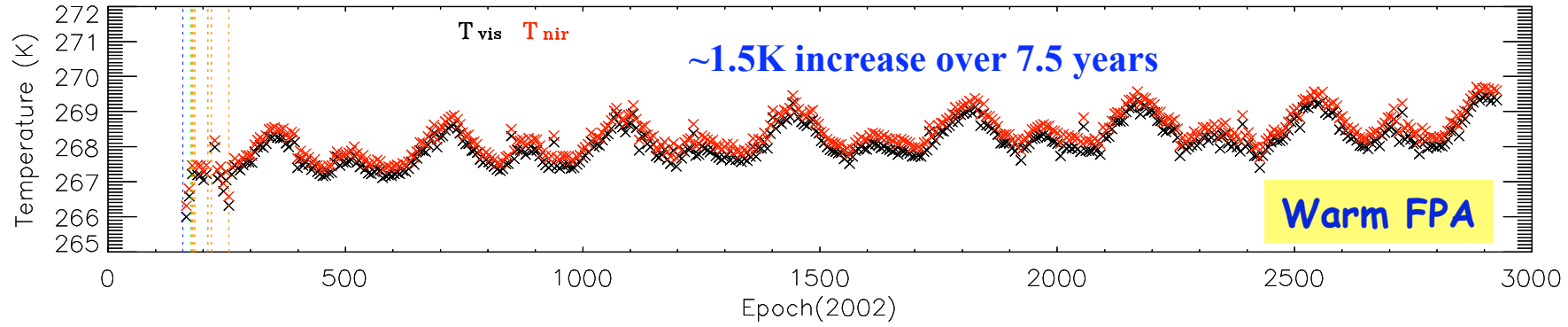


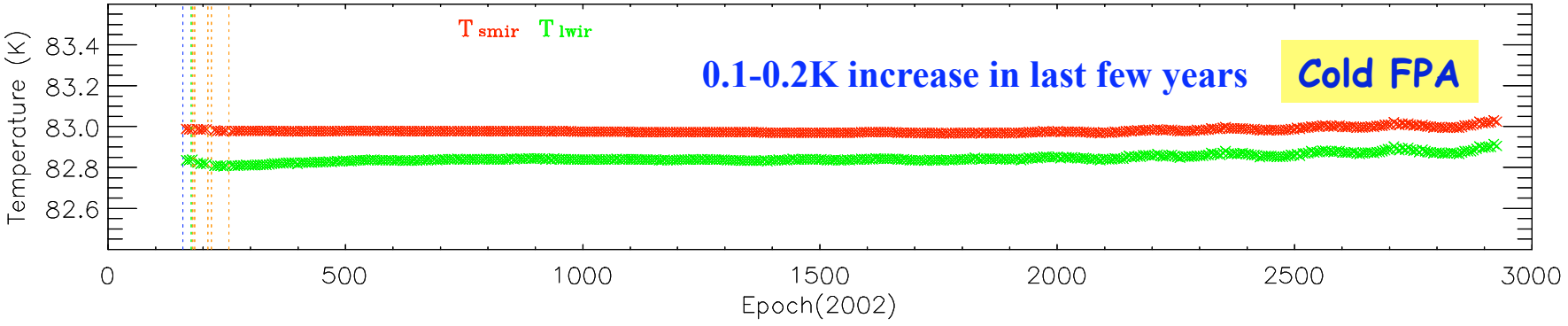


Vertical lines: configuration change, S/C or sensor events

Aqua MODIS Instrument and FPA Temperatures

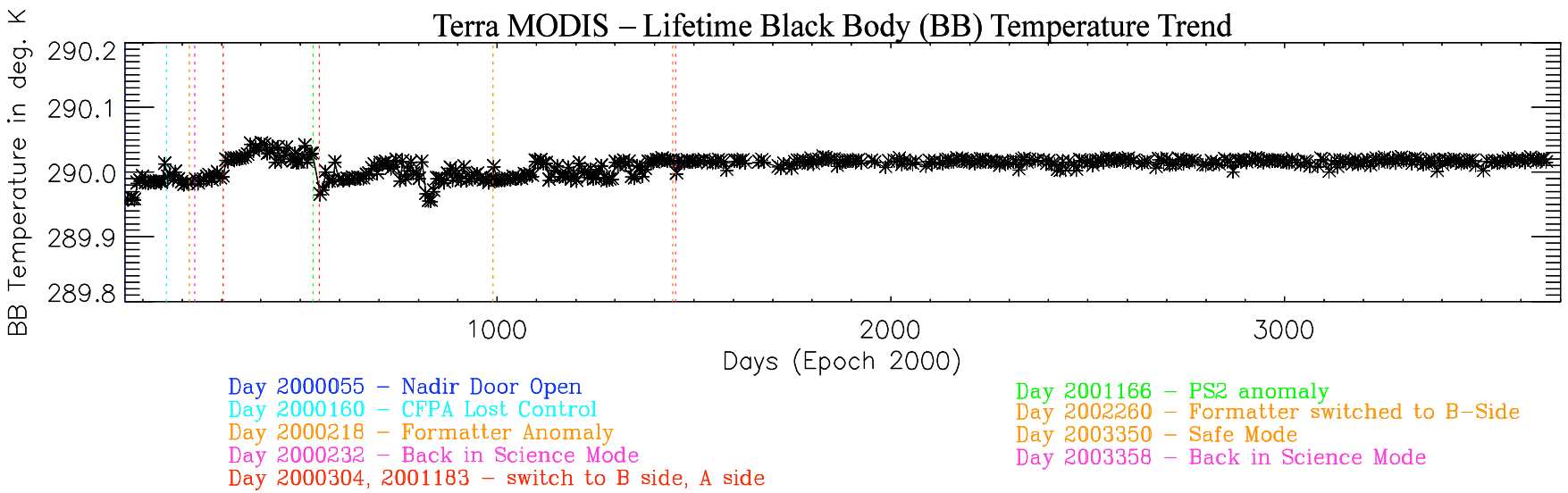


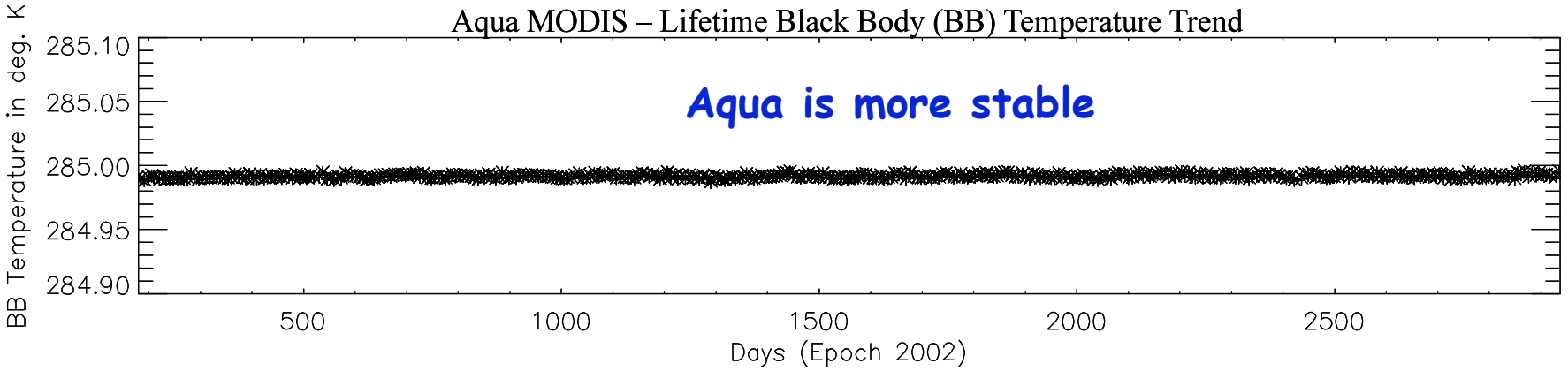




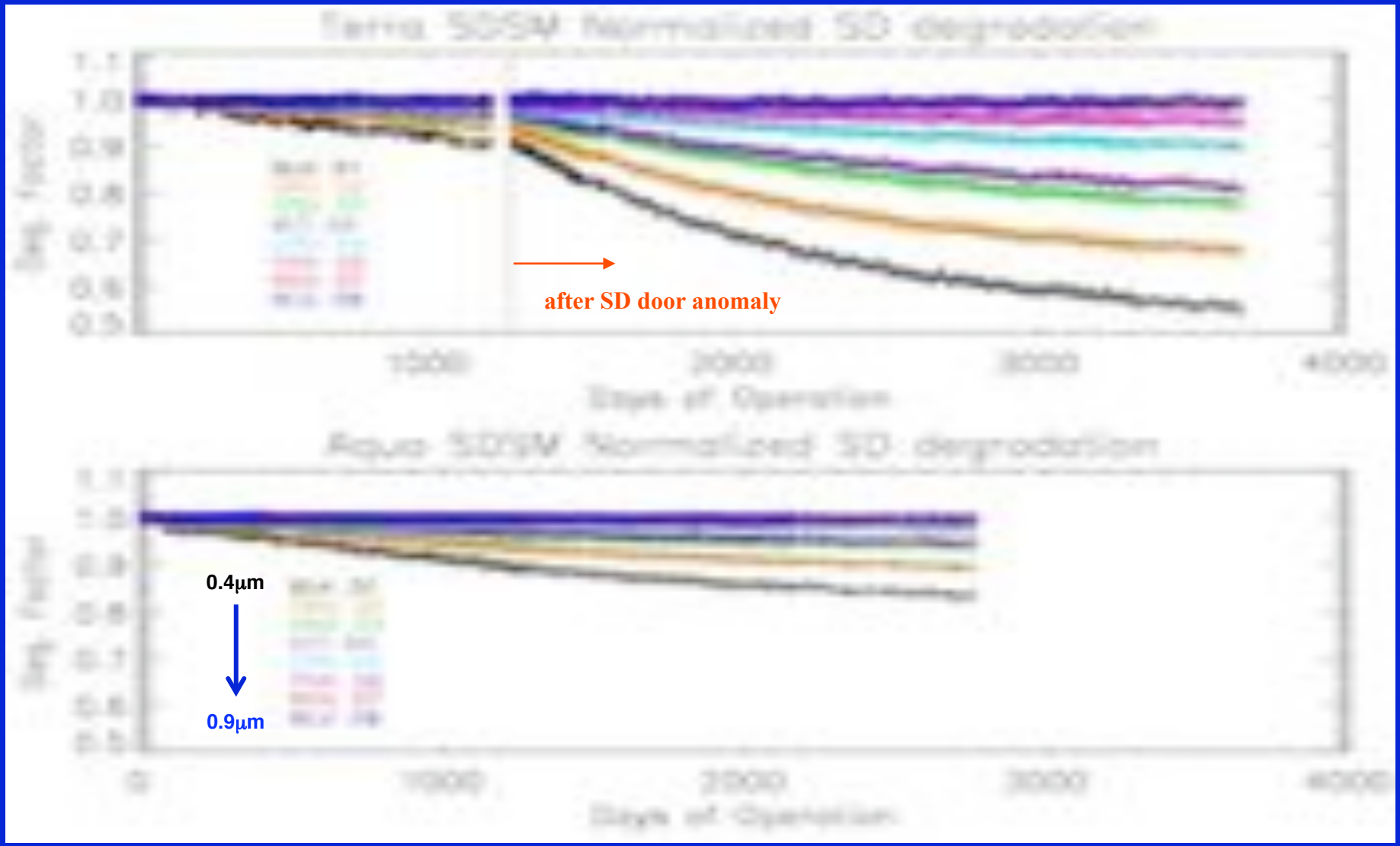
MODIS BB Temperatures

BB temperatures are very stable when operated under the same conditions





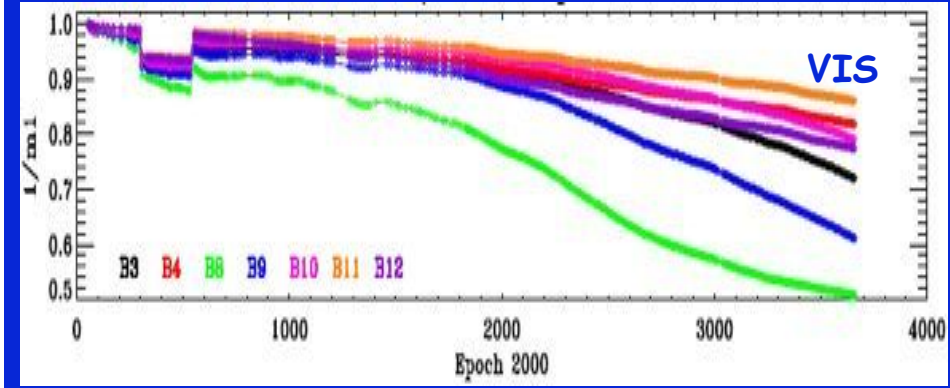
MODIS SD Degradation

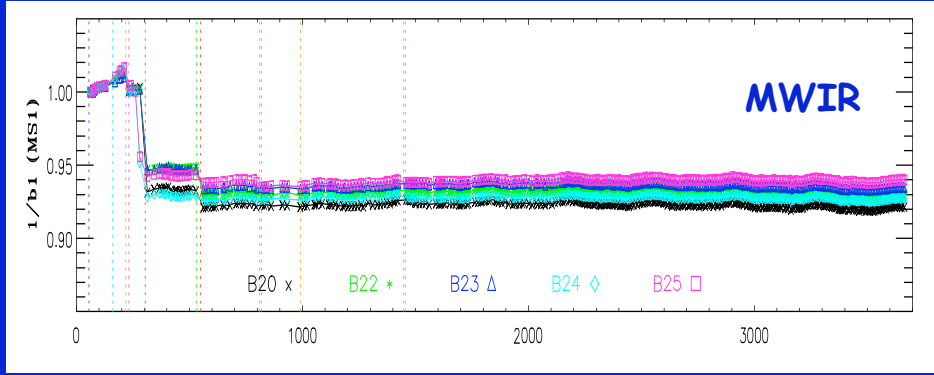


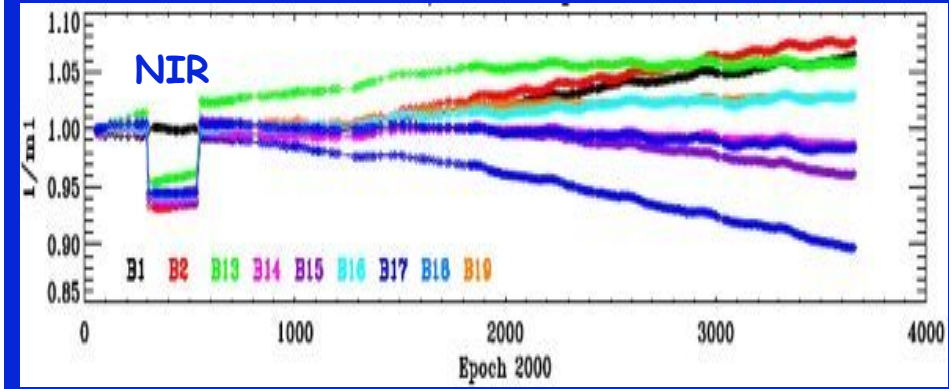
Increased SD degradation rates in Terra MODIS after SD door fixed at "open"

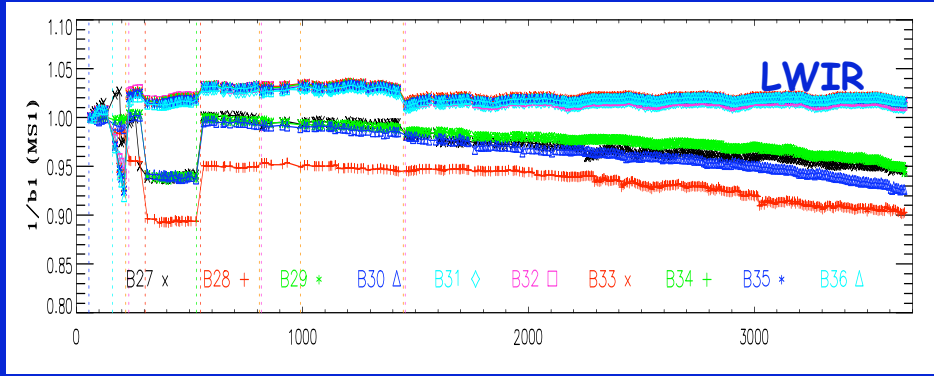
Terra MODIS Responses

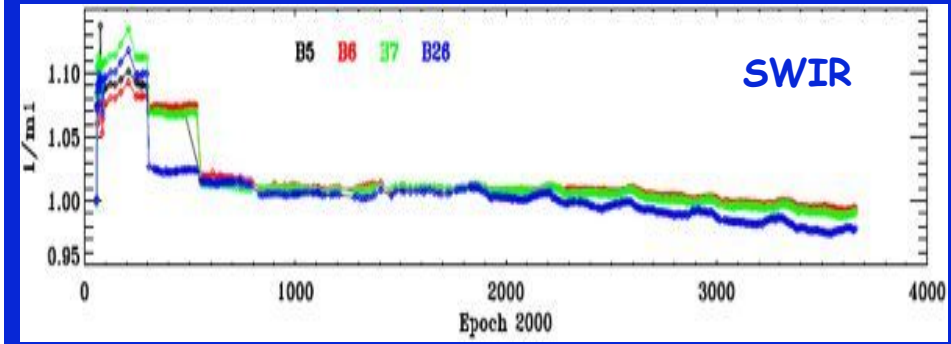
Band averaged, mirror side 1







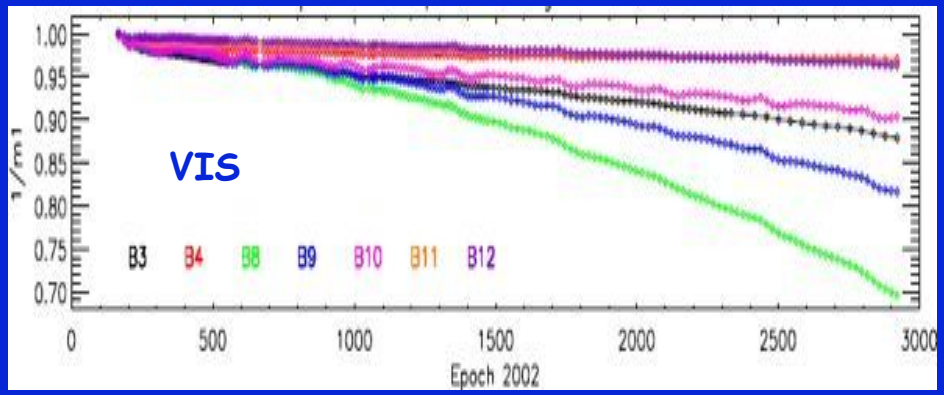


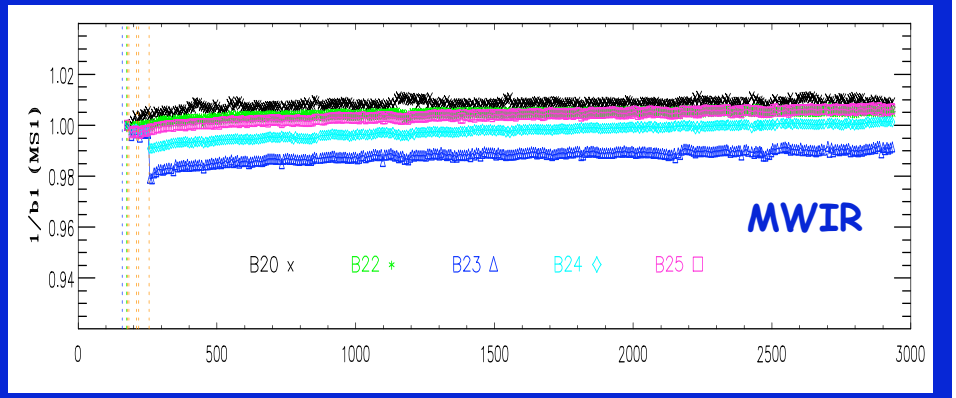


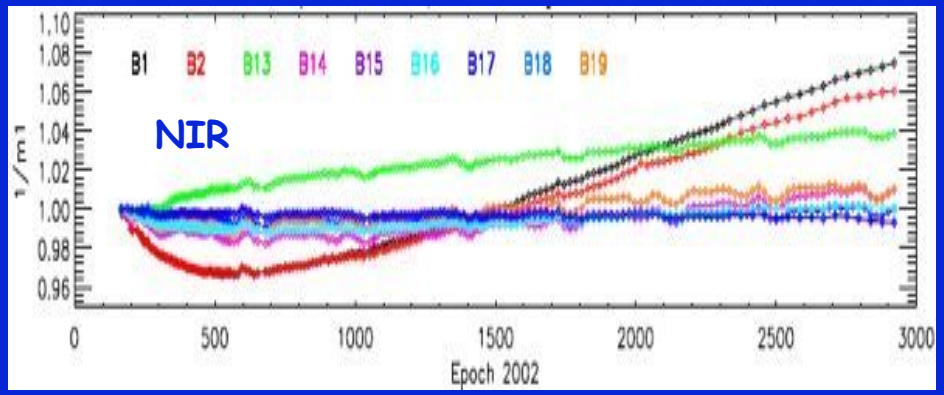
Changes in VIS: 15-50%
Changes in NIR: 10%
Changes in SWIR,MWIR/LWIR: < 5%
Changes are also mirror side and AOI dependent

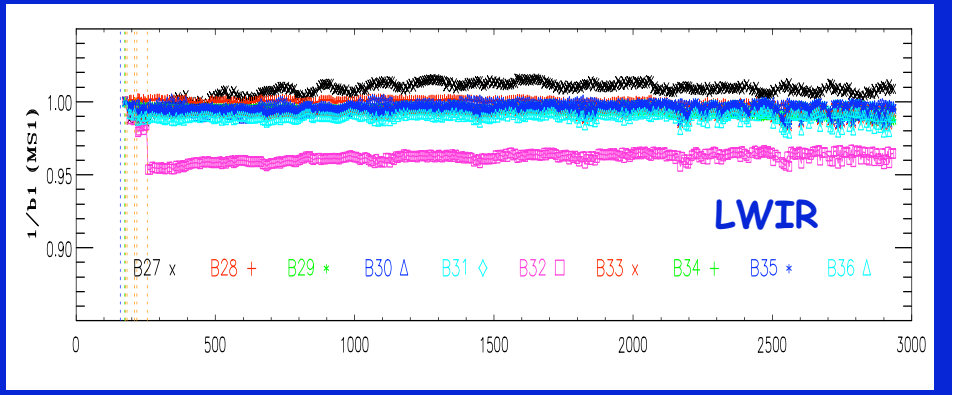
Aqua MODIS Responses

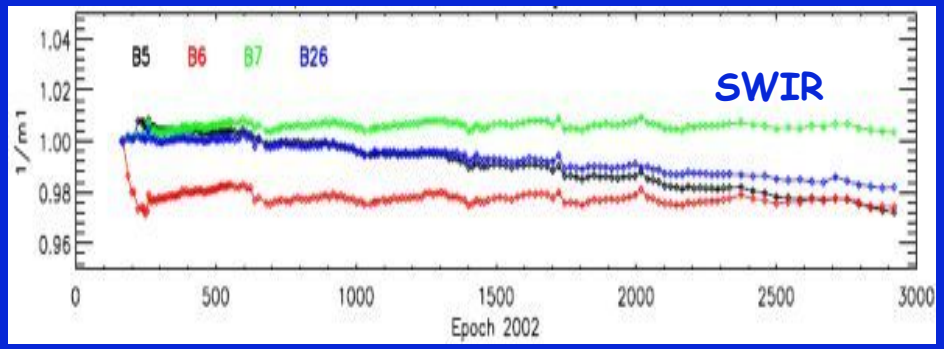
Band averaged, mirror side 1







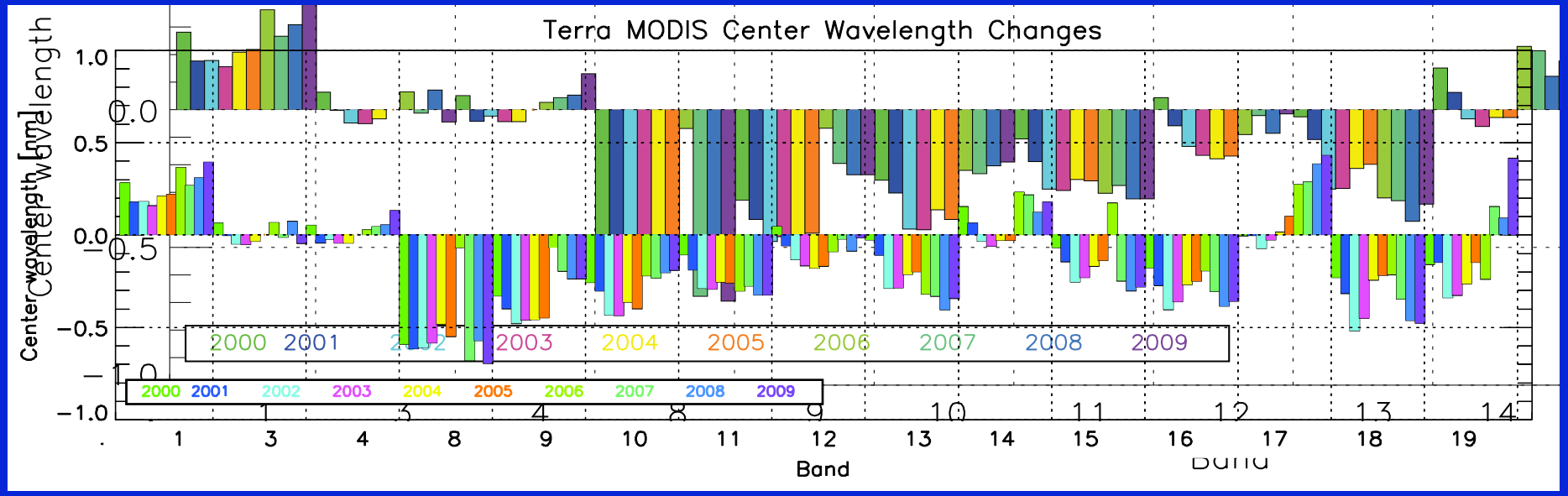


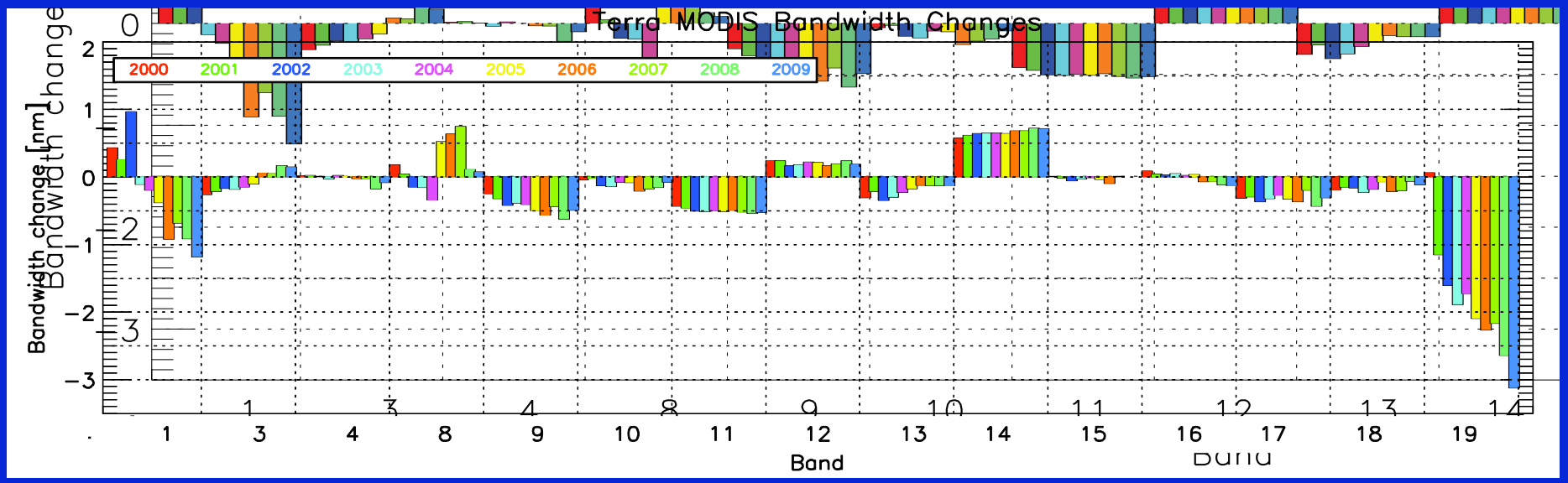


Changes are similar to Terra MODIS but generally smaller

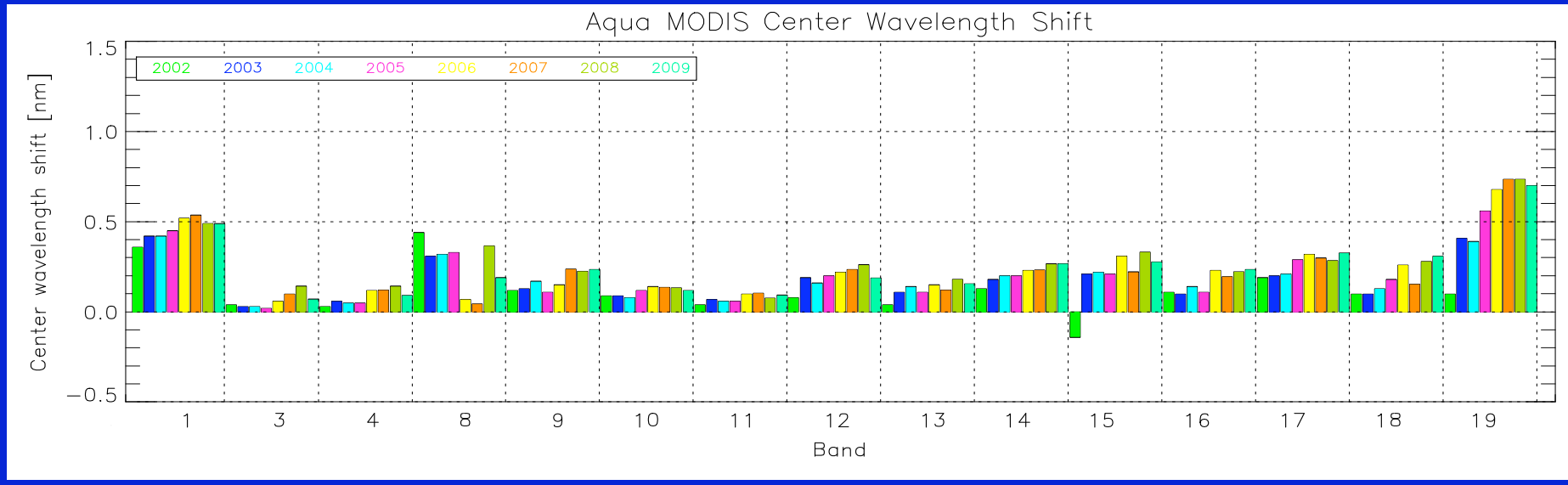
Mirror side differences are much smaller

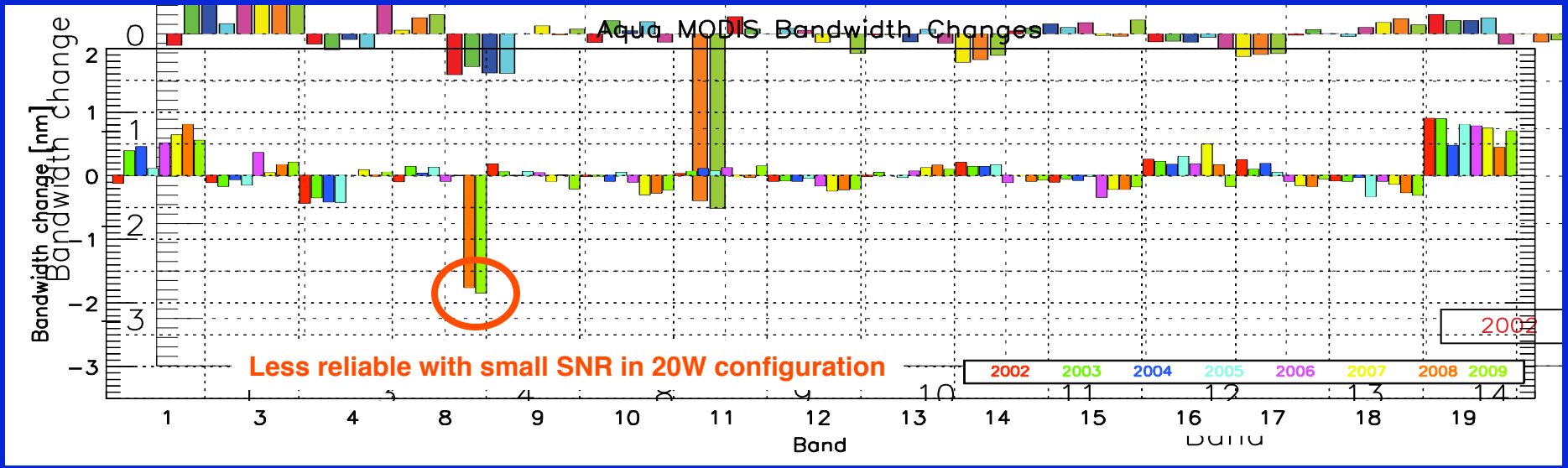
Terra MODIS Spectral Characterization



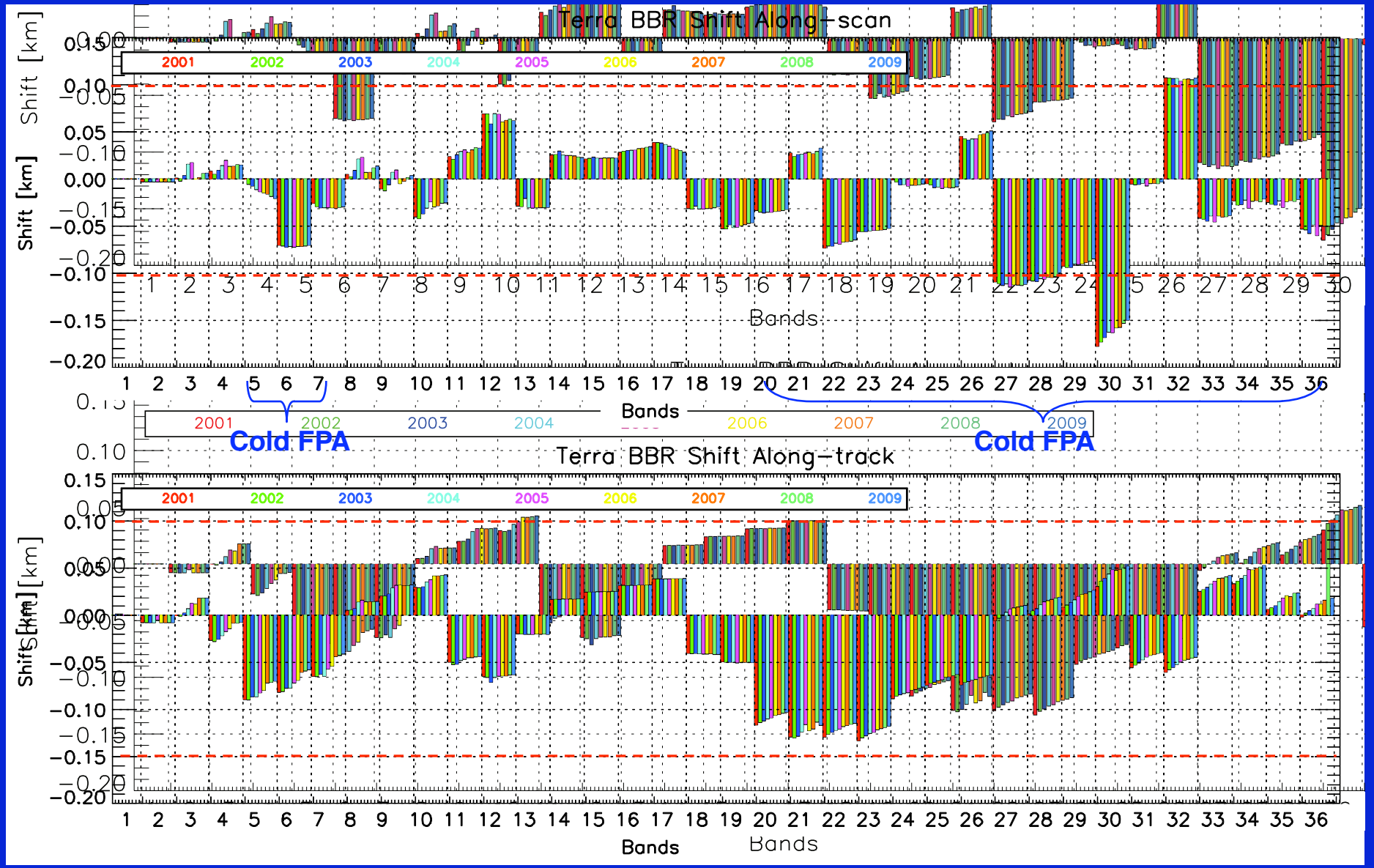


Aqua MODIS Spectral Characterization

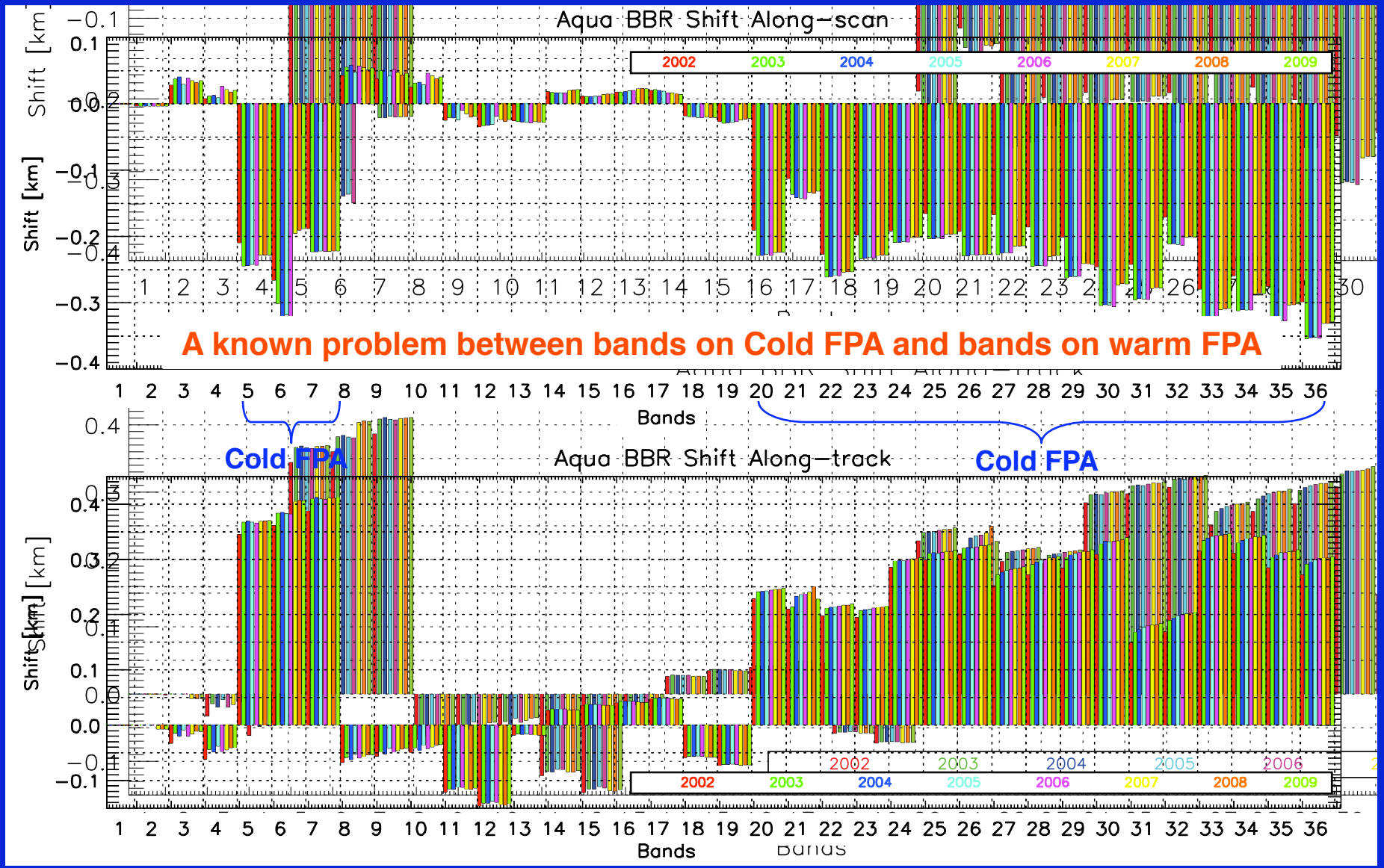




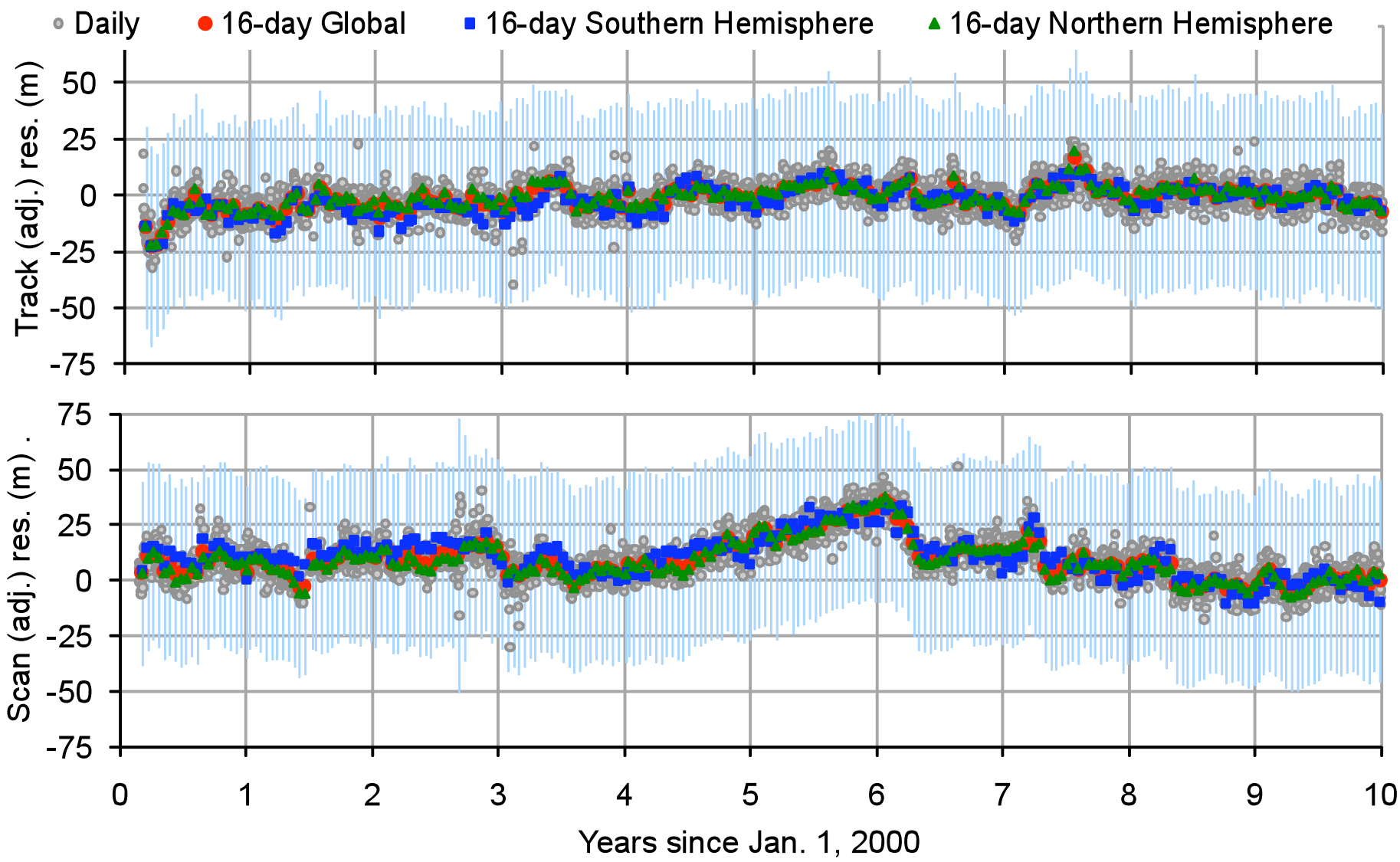
Terra MODIS Spatial Characterization



Aqua MODIS Spatial Characterization



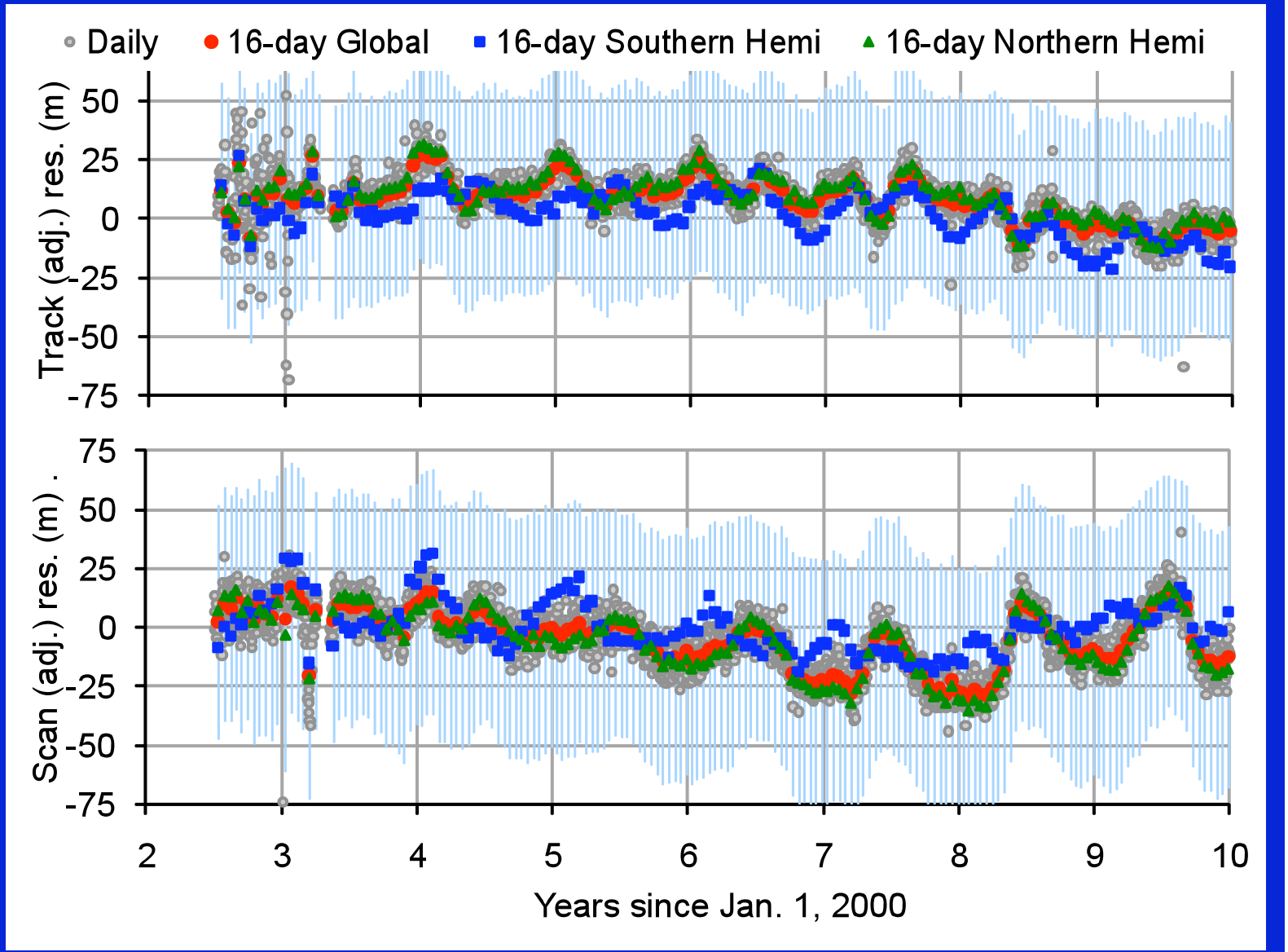
Terra MODIS Geolocation Results (C5)



Robert Wolfe et al. Track RMS: 43m (C5) Scan RMS: 44m (C5)

Aqua MODIS Geolocation Results (C5)

Note:
northern & southern hemispherical differences



Robert Wolfe et al.

Track RMS: 47m (C5) Scan RMS: 53m (C5)

Instrument Performance Summary (1)

- Both instruments continue to operate normally
  - Instrument and warm FPA temperatures changed less than 3K for Terra MODIS over 10 years; less than 2K for Aqua MODIS over 7.5 years
  - Terra MODIS cold FPA temperatures stably controlled at 83K
  - Aqua MODIS cooler margin slowly decreasing => small orbital and seasonal variations of the cold FPA temperatures (up to 0.15K)
- All on-board calibrators continue to provide their designed functions
  - Terra MODIS SD door fixed at the "open" position (July 2, 2003) => increased SD degradation rates
  - BB temperatures remain extremely stable: short- and long-term

Instrument Performance Summary (2)

- Radiometric (36 spectral bands: 490 individual detectors)
  - 45 noisy detectors (30 from pre-launch; 35 at launch) and no inoperable detectors for Terra MODIS
  - 6 noisy detectors (2 from pre-launch; 3 at launch) and 15 inoperable detectors (13 in band 6) for Aqua MODIS
  - Large changes in VIS response (mirror-side and AOI dependent)
- Spectral (VIS/NIR bands only)
  - Changes in center wavelengths and bandwidths are less than 0.5nm for most spectral bands (with a few exceptions)
- Spatial (all bands)
  - On-orbit band-to-band registrations (BBR) have been stable
  - Nearly all band pairs meet design requirements for Terra MODIS
  - Large BBR offsets in Aqua MODIS for band pairs with one from cold FPA and another from warm FPA (a known problem since pre-launch)

Instrument Performance Summary (3)

- Excellent geo-location accuracy and stability
  - Terra MODIS RMS (C5): along-track 43m, along-scan 44m
  - Aqua MODIS RMS (C5): along-track 47m, along-scan 53m
  - Enhance Terrain Correction (area-based) in C6
  - New DEM and land water mask in C6

- Calibration concerns and challenges
  - Large optics (mirror and SD) degradation at short wavelengths
  - Changes in response versus scan-angle (RVS) and polarization parameters for the VIS spectral bands (8, 9, 3, and 10)
  - Impact due to nonlinear response on VIS calibration coefficients
  - Terra and Aqua MODIS calibration consistency over entire mission
  - Impact of Aqua BBR for some products using bands from both warm and cold FPA

Collection 5 (C5) Processing Status

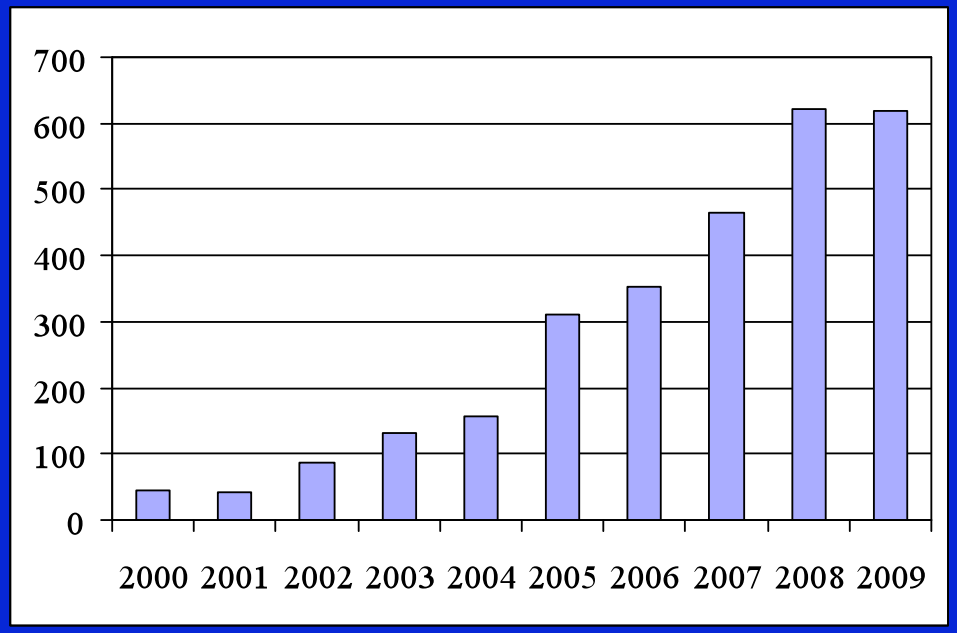
- Forward processing is typically 1-2 days behind real time
- The Aqua deep blue reprocessing (C5.1) was completed last year
  - Aqua C5 L1B is archived and instantly available from LAADS
- The Terra deep blue reprocessing (C5.1) through the end of 2009 will start mid-February and will take 5-6 months to complete
  - Terra C5 L1B will be archived in LAADS
- The C4.1 LST (C4 code with C5 L1 input) will be processed for the duration of C5
- C5 products will be generated through the completion of C6 reprocessing

Collection 6 (C6) Reprocessing Plan

- C6 L1 and Cloud Mask/Profiles
  - Codes will be validated by early April 2010
    - With the exception of a new 500m DEM (not available from DOD/USGS until June 2010).
  - All C6 L1B, geolocation, and Cloud Mask/Profiles products will generated and archived in LAADS in January 2011
- C6 Land and Atmospheres reprocessing
  - Codes will be ready in January 2011
  - Land C6 reprocessing will proceed at 20-30x and will be completed in the fall of 2011 (except LST at 15x, will be reprocessed as a separate stream and will be completed by the spring of 2012)
  - Atmospheres C6 reprocessing will proceed at ~35x and will be completed by mid-2011
- It is anticipated that the LP and NSIDC DAACs will ingest land products into their archives at these production rates
- All C5 atmospheres and L1 products will be archived in LAADS until the next major reprocessing

MODIS Publication Metrics

(as of Jan 24, 2010)



- Results from Web of Science: 2999 technical articles (all years); 4857 technical and proceedings articles (all years)
- Average citations: 9-10/per technical article

Google Scholar "HITS"

As of May 7, 2008 (shown at last STM)
19000 for NASA Terra
8750 for NASA Aqua
14800 for NASA MODIS

As of Jan 24, 2010
27100 for NASA Terra
11800 for NASA Aqua
19500 for NASA MODIS

Overall Summary

- Both Terra and Aqua MODIS instruments continue to work well
- Constant calibration and characterization effort remains critical
- High-quality data products are continuously developed
- Preparation of C6 reprocessing is making good progress
- DB of MODIS products plays an important role (over 150 stations)
- A broad range of applications have been made from MODIS observations
  - Science presentations in plenary and discipline sessions

Looking Forward